Title: Have You Heard about the Herd?

Link to Outcomes:

- **Problem Solving** Students will determine, in a cooperative environment, how to estimate animal population size, how animal populations fluctuate, and the factors that influence populations.
- **Communication** Students will communicate their positions on animal populations both orally and in written form.
- **Reasoning** Students will justify their reasoning for responses to real-world probability questions.
- **Connections** Students will prepare a writing sample demonstrating their understanding of the connection between mathematical probability and sampling with the study of populations of various animal species.
- **Estimation** Students will estimate animal populations.
- **Statistics** Students will determine animal population size through the use of sampling. Students will also determine the mean of a set of numbers. Students will generate a frequency table.
- **Probability** Students will determine the number of offspring of different animal species based on probability simulations.
- **Patterns** Students will interpret results and determine causes for variance.
- **Computation** Students will calculate percents from fractions.
- **Inquiry** Students will ask questions about populations and seek their answers through exploration and journal writing.
- **Life Science** Students will develop an understanding of populations and living systems.

Brief Overview:

Students will learn about mathematical sampling in order to determine population size, and the probability of the number of offspring within animal families. They will work on journal writing and respond to writing prompts in English class. Students will also participate in an all-day field trip to the zoo (in this activity the students will go to the Baltimore Zoo), maintaining a journal of responses to guided questions as well as observations and drawings of animals in their zoo habitat. Lastly, the students will demonstrate their ability to determine population sizes and write about how animal populations should be maintained in the zoo and in their natural environment.

Grade/Level:

Grades 6 - 8, with heterogeneous groupings.

Duration/Length:

This activity is designed to occur over a four day period within the context of an interdisciplinary team.

Prerequisite Knowledge:

Students should have a working knowledge of the following skills:

- Writing ratios of given quantities
- Solving proportions
- Performing basic operations on a calculator

Objectives:

- Students will work cooperatively in groups.
- Students will determine a sampling method.
- Students will estimate population size of a large population.
- Students will develop hypotheses about environmental factors effecting population size.
- Students will develop a journal of observations following proper English usage.

Materials/Resources/Printed Materials:

- Construction paper to use as covers of student-created journals
- Lined paper to make journals
- Unlined paper to make journals
- Number cubes for each pair of students
- One bowl for each pair of students
- Three large bags of Navy beans (Quantity to be determined through experimentation)
- One large bag of Pinto beans (Quantity to be determined through experimentation)
- 3x5 index cards for Animal Flash Cards
- 1 copy of the Baltimore Zoo map for each group
- Student Activity Pages contained within unit
- Teacher Resource Sheets contained within unit
- Calculators
- Colored pencils and pencils
- Maps of the Baltimore Zoo and field trip arrangements (contact the Education Department of the Baltimore Zoo at 410-396-6164 inside the state of Maryland, 410-396-6165 outside the state of Maryland)

Development/Procedures:

Day 1:

- **Science**

Students will work on a probability activity in which they roll number cubes to simulate determining the number of offspring of an unidentified animal. The activity can be extended to include the effect of uncontrolled growth in animal populations.

- **English**

Students will create their writing journals in class.

Day 2:

- **Science**

Using food chain cards, students will develop a food chain and food web, demonstrating their understanding of the effects of lack of food, increased predators, or other environmental factors on a population of animals. Students will be assisted in developing hypotheses about the effects of an animal's environment, both living and non-living, on the size of the population. Teacher directed discussion will focus on 1) the factors affecting population size, 2) factors affecting the numbers of offspring produced, and 3) the animal groups and groupings (social versus non-social animals).

- **Mathematics**

Students estimate animal populations through the use of a capture-recapture simulation. Students think-pair-share to discuss proper sampling techniques and then have a class discussion. Discussion should include the idea and definition of sampling and that a good sampling should be a representative sample. Students should record observations and take notes on the activity in their journals. Answers to the worksheet will vary, but the goal is an estimate of one hundred groundhogs.

- **English**

Continue journal writing experience with a review of the importance of journal writing and accuracy. The students will also use their journals for answering questions.

Day 3:

- **Field Trip to the Baltimore Zoo**

Dividing students into groups of four, provide each group with a set of colored pencils and a copy of the zoo map. Students carry their own journals. They are to follow their zoo maps and are told to meet at the Prairie Dog Cafe at Polar Bear Square for lunch.

Day 4:

- **Science**

Using information gained through observation and directed zoo journal drawings and writings, students will estimate expected population increases in the zoo environment. Teacher directed discussion will focus on the preservation of species of animals: Which environment affords the greatest possibility of conservation of species, the zoo or the natural environment? There are valid points on each side. Students should be directed to support their theories with actual information gained through observation or research. (Extension: What shape cage would give the animal the most space to move around? If five cages with that shape are set up so that each cage touches two other cages, what could be done with the "leftover" space?)

- **Mathematics**

Working in pairs, Students estimate animal populations of various sizes as an assessment activity. The assessment will include an estimation of the population involved, the work involved in finding their estimate, and a writing prompt. The writing prompt is "Imagine that you are assisting in the training of new workers to the park. Write a training manual in your journal for the new employees to learn how to accurately make population estimates."

- **English**

This lesson will focus on evaluation and discussion of the journal writings. The final questions for the zoo trip will be completed during this time.

Evaluation:

The evaluation of this activity is done through observation of the students working during the first three days of the project and through assessment exercises on Day 4. These exercises will involve experiential activities based on previous activities and writing prompts based on student experiences. Rubrics for these activities are included in this unit.

Extension/Follow Up:

Extensions can be done to include social studies classes, incorporating climographs, biomes, and ecology. The connections to the activity can be made through talking about environmental factors that are involved in determining animal populations. Other extensions can include the family lives of the animals (especially convenient at the Baltimore Zoo due to the identifiers on animal signs describing the ways animals live in the wild), environmental issues (the vanishing rainforest), and the growth of endangered species in various locations. Also possible is the discussion of animal habitats, preserves, and the humane treatment of animals.

Authors:

Nelia D. Tyma	Edward C. Nolan	Cynthia H. Sadula
Eastern MS	Forest Oak MS	Eastern MS
Montgomery County	Montgomery County	Montgomery County

Name _____

Date _____ Class ___

Science Activity - Day 1

Directions: Working in pairs, roll a number cube twenty times to determine the tally and count of the number of offspring produced by a pair of animals. As you roll each time record the result by placing a mark in the tally column.

Number of offspring	Tally	Number	Fraction
1			/20
2			/20
3			/20
4			/20
5			/20
6			/20

Assemble the information from your group (two pairs of students) and enter the group information on the class data chart.

Class Data Chart

Number of Offspring	Group Counts	Total	Fraction	Percentage
1				
2				
3				
4				
5				
6				

Name _____

Date _____ Class ___

Science Activity - Day 1 - Page 2

Questions:

1. What number appeared most often on the number cube? _____

2. What is the most probable number of offspring that might be produced by these animals? _____

3. If the first generation had 20 opossums, 10 males and 10 females, how many offspring would they most probably have? (We'll call this offspring generation #1.) ***(show your work)***

4. Assuming that numbers of males and females are even in the population in question #3, how many opossums would there be in the next generation (offspring generation #2)? (Remember, the **parents** of offspring generation #1 can still have more babies!). What would be the effect of having an odd number of males and females in the population?

Journal Writing in Science at the end of Day 1 (or Homework):

Of course we've forgotten something! Is there anything that could change the number in the population (other than the number of males and females)? See how many you can list (I've started you off with an idea)

1. A fox might eat an opossum.

Teacher Resource Sheet - English Days 1 and 2

Directions for making a zoo journal:

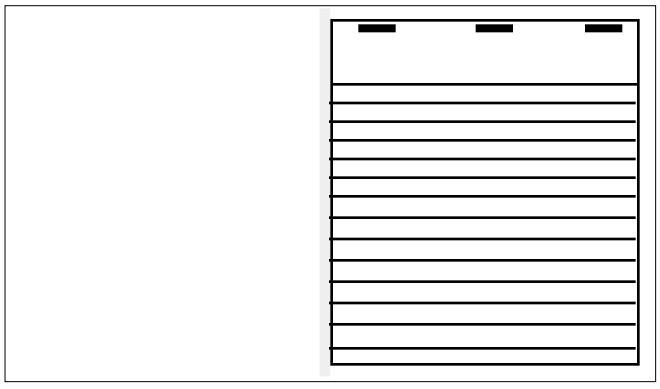
The zoo journal is not only an opportunity for the students to complete the given exercises, but also a chance for them to show their creativity. The journal should be made using a construction paper or plain paper cover and include both lined and unlined paper. Students should be encouraged to decorate their journals and personalize them in any way that they see fit. Groups may also decide to focus on a theme for their covers so that they can link together as a group.

Directions for constructing the actual journals:

•Order of journal pages
- -one sheet of construction paper per student
- -several sheets of lined paper for each student
- -several sheets of unlined paper for each student
- -Student Zoo Activity Sheets- Day 3

• Materials
- -staplers
- -colored pencils

•Procedure
- -Hand papers out to students. Construction paper is for the cover.
- -Have students stack all the necessary sheets in the appropriate order on top of the construction paper.
- -Students then staple the top side of the sheets to the construction paper.
- -Fold the construction paper in half to form a booklet. The students can then put their name, date and class on the front of the booklet.



Teacher Resource Sheet- English Days 1 and 2 - Page 2

Directions on the use of a zoo journal:

Observations of nature in its many forms are valuable. The purpose of a zoo journal is to allow students time to make different kinds of observations.

The first kind of observation is in the form of drawings. These pictures are carefully drawn by the student while making observations of the animal and its environment, whether that is a traditional cage or some other kind of protective environment. The drawings of the animals may be either of two possibilities: 1) gesture drawings (a record of the motion of living things) or 2) memory drawing (drawings based upon the recalled observations of the animal in its environment).

The second kind of journal entry is written. These are impressions of what is seen. These written impressions are made *in addition* to drawings. The two types of observations should be different. Use the questions that have been given for the zoo trip to guide observations.

Directions for writing a zoo journal

Before going to the zoo it is a good idea to model the specific activity you expect the children to accomplish. To assist you please read the following directions:

1. Drawings: *(Choose an animal that most of the children are familiar with, for example a squirrel or neighborhood bird.)*

a. Gesture drawings: Direct the students to look at a moving object, observing its character and form. (We would suggest that you use either a laser disc image or a video tape image for observation.) They should focus on one individual animal, designing their drawing to take up the whole page. The goal here is to capture the animal in motion therefore student drawings are expected to be rather scribbly and playful.

b. Memory drawings: Once again, direct the students to carefully watch a video tape or other image of an animal in motion. After viewing, then open record on paper a sketch of the animal.

2. Written entries:

a. Direct students to write observations (color, relative size, body covering, etc.) in the space next to the sketch that they made. (Again, modeling this activity is valuable.)

b. Using one or two of the questions for the zoo field trip, have the students propose possible answers. Write these answers in a space below the sketch and general observations so that students can see them.

Teacher Resource Sheet - Science - Day 2

Who eats what?

As the students enter the classroom each student draws one card from the deck of teacher-made food chain cards (Teacher creates enough cards for each student to receive one card) (See Teacher Resource Card examples). Students must find their two matches: 1) what their organism eats and 2) what eats their organism. Sometimes students will need expert advice from the teacher about their animal or plant. Be familiar with the animals and plants listed on the cards you hand out, if necessary, look them up beforehand in the encyclopedia. Since some students will not have completed a unit on ecology, biomes, or environments before completing this exercise, you may choose to use only those animals and plants that are familiar to your students.

Students write in journals:

1. What would happen to the population of squirrels if the population of foxes increases?

2. What would happen if there was a draught and the nuts that the squirrels eat were not as plentiful?

Pre-zoo discussion:

Many animals are social. List on the overhead or chalkboard the animals that students think are social. (Help them out as needed with suggestions about words that mean groups of specific animals - for example, herds of goats, gaggle of geese, etc.)

Are there any animals that live in families? How about birds? Do the two parents stay around the nest with the babies that hatched from the eggs?

Journal Writing Science : Day 2

Do you think the zoo helps family type or social animals live better?

Question for the zoo visit:

List some animals that live in families. Give one observation that helps you know it is a family animal. Do the same for social animals.

Teacher Resource Sheet -Science - Food Chain Card Examples

Squirrel	Fox
Corn	Mouse
Owl	Hawk
Earthworm	Grass

Mathematics Activity - Day 2

Warm-up

Think of yourself as an Ecological Scientist and your task is to estimate the groundhog population in Black Hills Regional Park. List the different ways that you could estimate or determine the size of the groundhog population.

Would the same procedures be appropriate to estimate the groundhog population in the entire United States?

Why or why not? Justify your answer.

Teacher Resource Sheet - Mathematics - Day 2

Estimating Animal Populations by Capture/Recapture Simulation

Step 1: Keep the students in groups of two from the warm-up.

Step 2: Distribute a bowl of navy beans to each student. Each bowl should have exactly 100 navy beans in it, but students should not know this at the start. Each bowl should be lettered in some way so as to indicate that bowls may contain different quantities. This will also allow for data collection later in the activity.

Step 3: Discuss with the students that the navy beans are to represent the number of groundhogs in Black Hills Regional Park. "We don't know how many groundhogs are in the park, but we don't want to catch all of them. So let's do a sampling of the groundhogs and work on an estimation of the groundhog population," should be typical conversation at this stage.

Step 4: Discuss with students that they are going to "capture" a certain number of 'groundhogs', tag them (which we will represent by replacing them with pinto beans), and replace them in their environment. Be sure that students are instructed to take less than 50 beans at one time.

Step 5: Have a supply of pinto beans for the students to use as replacement groundhogs.

Step 6: The students are then to mix the beans and draw a sample of the mixed population (a combination of previously and uncaptured groundhogs) and count both the total number of groundhogs and the number of previously captured groundhogs. Discussion at this stage should include one of the weaknesses of this type of sampling - that it is assumed that the groundhogs will 'mix' with all of the uncaptured animals. There is the possibility that the captured animals will stay in the same location and skew the data.

Step 7: Students are next to place their findings into a proportion:

$$\frac{\text{Tagged Groundhogs}}{\text{Total Number Caught}} = \frac{\text{Total Number Tagged}}{\text{Total Population}}$$

OR

$$\frac{\text{Pinto beans pulled}}{\text{Total beans pulled}} = \frac{\text{Pinto beans placed in}}{\text{Total number of beans}}$$

Teacher Resource Sheet - Mathematics - Day 2 - Page 2

Step 8: Have the students solve the proportion and estimate the population.

Step 9: Have the students replace the selected beans, navy and pinto, back into the bowl and mix well.

Step 10: Have the students repeat steps 6 through 9 three times to obtain four population estimations. The students are to find the mean of their four estimations.

Step 11: Place the letters of the bowls on a chalkboard or overhead and have the students place their estimation for populations as they finish.

Step 12: Have the students find the mean for all of the populations and discuss their accuracy (remember there are 100 beans in each of the bowls).

Step 13: Discuss the results and their accuracy. Have the students determine causes for variance in their results.

Step 14: Have the students complete an entry in their journals (possibly for homework) in which they summarize the process of estimating populations and write down any reflections they have about the process. Students will be able to use this journal on Day 4 during the assessment.

Guiding Questions for Journal Writing:

1. Summarize the process of estimating populations. How would you explain to someone who isn't in your class how you estimated the populations? What are the advantages of this type of sampling? What are the disadvantages of this type of process? Justify your reasoning.

2. Why do you think that the first sampling we did would not be the best test to get a representative sampling of the population? Explain your answer.

3. What are some examples of potential variances in your results? How could the knowledge of these variances be applied to the population surveys in the Black Hills Regional Park? Explain your answer.

Name _____

Date _____ Class ___

Mathematics Activity - Day 2

Estimating Animal Populations by Capture/Recapture Simulation

Your job is to estimate the population of groundhogs in Black Hills Regional Park. In order to do this, you must first work on how to estimate the number of groundhogs without actually counting each one! Here's what we're going to do:

Step 1: Get into groups of two.

Step 2: Get a bowl of beans. Each bowl is lettered so as to indicate which bowl you will be counting. This will also allow for data collection later in the activity.

Step 3: The beans are to represent the number of groundhogs in Black Hills Regional Park. Discuss with your partner, then the class, that it will be easier to estimate the population then to count each individual groundhog!

Step 4: Withdraw some of the beans to represent the capturing of groundhogs. Replace to captured groundhogs with different colored beans so that you can tell they have been "tagged."

Step 5: Mix the beans and draw a sample of the mixed population (a combination of captured and uncaptured groundhogs) and count both the total number of groundhogs and the number of previously captured groundhogs. This is recapturing!

Step 6: Complete the chart:

Number of Tagged Originally	Number of Tagged Recaptured	Total Number of Recaptured

Name _____

Date _____ Class ___

Mathematics Activity - Day 2 - Page 2

Step 7: Place the numbers into the following proportion and solve for your total population estimate:

$$\frac{\text{Tagged Recaptured}}{\text{Total Recaptured}} = \frac{\text{Originally Tagged}}{\text{Total Population Estimate}}$$

Questions:

1. How many groundhogs did you originally tag? _____ groundhogs

2. How many tagged groundhogs did you "recapture"?
_____ groundhogs

3. Using the given proportion, what is your total population estimate?
_____ groundhogs

Step 8: Replace the recaptured beans into the bowl and mix well.

Step 9: Repeat steps 5 through 8 three times to obtain four population estimations. Complete the chart:

	Tagged Originally	Tagged Recaptured	Total Recaptured	Total Population Estimate
Trial 1				
Trial 2				
Trial 3				
Trial 4				

Mean of the Total Population Estimates: _____ groundhogs

Mean of the Total Population Estimates for the Whole Class:
_____ groundhogs

Name _____

Date _____ Class ___

English Activity - Day 2

Journal Writing

Directions: Answer the following questions in your journals.

1. We are going to the zoo tomorrow to look at animals and their families.

   • Based on what you have learned so far in your classes, what would you like to learn about animals and their family life?

   • How will you go about finding the answer to your questions?

   • What strategies will you use to make the best use of your time while at the Baltimore Zoo?

2. What skills do you think would be helpful for a scientist doing animal family research? Explain your reasoning.

Name _____

Date _____ Class ___

Zoo Activities - Day 3

Directions: Visit each of the following sites. The locations are numbered as they are on your map of the Baltimore Zoo. You may go in any order. As you visit each site, answer the questions on your own paper.

In the Main Valley

Location #1. Kodiak Bear

1. What is the diet of the Kodiak?

2. What is the natural habitat of these bears?

3. Are the Kodiak Bears active at day (diurnal), night (nocturnal), or, dawn and dusk?

4. What is their social grouping?

5. Draw a picture of the cage in which the bears are housed. Label the parts of the cage.

Location #2. Small Birds, Cranes, Vultures.

1. What is the diet of the small birds, cranes and vultures?

2. List the diet, habitat and activity of each species you see.

3. What is the benefit for each species of being in this type of social group? What would be the draw backs? Explain your reasoning.

4. Draw a picture of the cage in which these animals are housed. Be accurate!

Name _____

Date _____ Class ___

Zoo Activities - Day 3 - Page 2

Location #5. Polar Bears

1. What is the diet of the Polar bear?
2. What is the natural habitat of these bears?
3. Are the Polar Bears active at day (diurnal), night (nocturnal), or, dawn and dusk?
4. What is their social grouping?
5. Draw a picture of the cage.

Location #6. Flamingos and Waterfowl.

1. What is the diet of these birds?
2. What is the natural habitat of these birds?
3. Are these birds active at day (diurnal), night (nocturnal), or, dawn and dusk?
4. What is their social grouping?
5. Why do you think this social grouping would be beneficial for the birds? Explain your answer.
6. Draw a picture of the cage.

Name _____

Date _____ Class ___

Zoo Activities - Day 3 - Page 3

African Exhibits

Choose at least five (5) locations in the African exhibit to visit. Name the area you are visiting. For each exhibit, evaluate the species':

- diet;
- habitat;
- activity level; and
- grouping (social).

Draw a picture of how the animals' environment was designed.

You choose!

Choose two (2) of the following exhibits: Hoofed Mammals, Mammal House, Eagles, or Reptile House.

Questions for Your Choice!

Exhibit #1 _____

How is this exhibit designed differently from the other exhibits you have seen today?
Explain your answer in words as well as draw a diagram of this exhibit.

Exhibit #2 _____

How is this exhibit designed? Draw a picture .

Do you think this environment is beneficial for these animals?

Compare these environments to others you have seen today. What are the similarities and differences that you have observed?

Teacher Resource Sheet - Science - Day 4

Warm-up: Using Think-Pair-Share make a list of all animal families observed at the zoo.

Activity: (Students will need their journals in class today. There is a short directed journal writing that will be completed in class today.)

Present students with a list of endangered species. (These lists are available through the United States Department of the Interior, or from your state department of natural resources.)

How many of the animals listed were seen at the zoo?

How many of these animals had offspring in the cages with them?

Journal Writing Activity:

Considering how many animals had offspring with them, is the zoo a good place to preserve endangered species? Could there be any special reason why there are few animal babies seen in the zoo?

Time permitting: Students should be directed to design a section of the zoo that would allow the most space for movement of the animals.

What shape cage would allow for the most movement of an animal? Make a drawing showing five cages of this shape side by side (each cage should be touching at least two other cages). Is there any additional space in between cages? If there is, could you store food for your animals in this area? Put one animal in each of the cages. What sorts of criteria would you use to determine the animals to be put in each cage?

Name _____

English Activity - Day 4 Date _____ Class ___

Journal Writing for Zoo Activities

1. Think about the social grouping for the Kodiak Bears. Why do you think this grouping would be beneficial for the bears? Explain your answer.

2. Now think about the habitat of the small birds, cranes and vultures. Do you think their habitat influences its social grouping? In other words, does where they live create any difference in how they live?

3. Why do you think that the social grouping for the Polar Bears helps them in the way they live? Explain your answer.

4. Do you think that the way Polar Bears live makes a difference in the food they eat? Explain you answer.

5. Compare what you observed about Flamingos and waterfowl to what you observed about the small birds, cranes and vultures. What are similarities? What are differences? Be sure to support your answer with examples from your journal.

6. Examine the drawings you made of each exhibit. What are the similarities you observed? What are the differences?

7. What are the advantages of having the animals' environment like the cages in the Main Valley? What do you think would be the disadvantages? List at least two of each. Be sure to justify your answers.

8. Look through your drawings of the habitats in the Africa exhibit. What is the differences between these habitats and the environments in the Main Valley? What are the advantages of the type of housing in the Africa exhibit?

9. Why do you think that the zoo planners changed the style of housing from what you saw in the Main Valley to the style in the African exhibit?

10. Do you think that the changes the planners made were beneficial to the animals or that the changes influenced the animals' adaptation to the zoo?

11. What did you learn today that you did not expect to learn? What did you want to learn and actually found the answer at the zoo? How did going to the zoo help you understand populations and family life of the animals?

Teacher Resource Sheet - Evaluation Rubric

Evaluation is based on all aspects of this unit: English, Science and Math.

Expectations for each aspect are explained to the students at the beginning of the unit.

The rubric is as follows:

English

- Student has answered all questions.
- Student has answered all questions with appropriate sentence structure.
- Student has answered all questions in paragraph form.
- Student has answered all questions and has justified the answers with appropriate supporting statements.
- Student has constructed the journal according to directions.

Science

- Student has made either gesture or memory drawings of each animal.
- Student has listed written observations beside each drawing.
- Student has responded to guiding questions.
- Student has determined population change over two generations of offspring.
- Student has determined environmental factors responsible for population change.

Math

- Student has accurately solved proportions.
- Student has demonstrated ability to sample populations.
- Student has accurately estimated simulated animal population.
- Student has described most of the simulation process accurately in writing.
- Student has written to a given audience.